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AUTOMATIC APPARATUS FOR INTERMITTENT TESTING

BY

G. W. VINAL, Associate Physicist
L. M. RITCHIE, Assistant Chemist
Bureau of Standards

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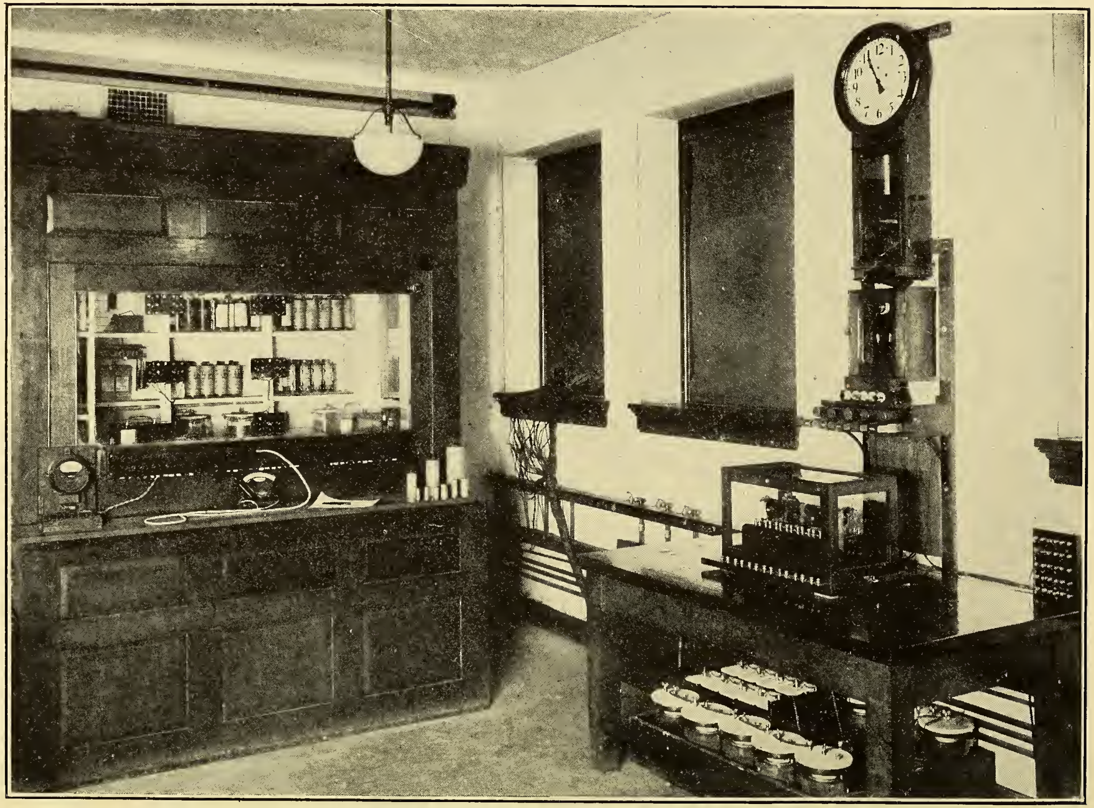

FIG. 1.—*Complete view of the new automatic apparatus for intermittent testing. The clock controls the selective relays under the glass case on the table. This apparatus can carry on simultaneously a number of different tests on dry cells and storage batteries. Dry-cell tests are made in the constant-temperature room at the left. The voltage of each group of batteries may be read at the telephone jacks beneath the window*

AUTOMATIC APPARATUS FOR INTERMITTENT TESTING

By G. W. Vinal and L. M. Ritchie

1. INTRODUCTION AND APPLICATION

This apparatus has been devised to meet the needs of the Bureau of Standards in making tests of dry cells and storage batteries, but is applicable to nearly any form of intermittent test requiring the closing of electrical circuits at regular time intervals.

The usual tests of dry cells which are made at the present time are arbitrary. They involve the discharge of the cells through resistances for varying periods of time, depending upon the service for which the particular cells are designed. The telephone test, frequently referred to as the "A. T. and T. test," consists of a discharge of 3 cells in series during 4 minutes per hour for 10 consecutive hours a day, but omitting every other discharge period on 1 day of the week. The "ignition test" for cells which are designed for a heavier type of service involves a discharge of the group of cells for 1-hour periods twice each day. The "flashlight test" requires a discharge of the cells for 5 minutes once during 24 hours. The details of these tests may be found in Circular No. 79, Electrical Characteristics and Testing of Dry Cells, published by the Bureau of Standards.

Additional tests which may be made simultaneously with these include the life-testing of storage batteries and intermittent tests of caustic-soda primary batteries, such as are used for railway signaling. The life tests of storage batteries consist of a continuous series of charges and discharges, 2 complete cycles being made in each 24 hours, without requiring the presence of an observer. Researches on the capacity of various batteries for differing periods of discharge are planned also.

2. DESCRIPTION OF CONTROL APPARATUS

A general view of the apparatus[1] is shown in Fig. 1. The pendulum clock, in which an electrical contact has been placed, closes the circuit once every minute and furnishes an electrical impulse to one of two selective relays which are contained in the glass case on the table. The details of these relays may be more clearly seen in Figs. 2 and 3. As each impulse is received, the shaft at the left-hand end is advanced by one-sixtieth of a revolution, and therefore it makes 1 complete revolution per hour. Once an hour this shaft furnishes a similar impulse to the coils at the other end of the apparatus, which causes the shaft at the right-hand end to rotate. There are 24 teeth in the wheel at this end, and this shaft therefore makes 1 revolution in 24 hours. The third shaft is geared to the 24-hour shaft in the ratio of 1 to 7 and makes 1 revolution in a week. By placing suitably-designed commutators on these three shafts the apparatus may be made to control any required periodic test.

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[1] We are indebted to Matthew Harrison and F. M. Defandorf for valuable assistance.

Owing to the inertia of the commutators on these shafts, it was necessary to use a driving mechanism similar to the escapement of a clock, in order that the shaft might not turn by more than the given angular amount when the armature is operated by the current in the magnet coils. The commutators are made of hard rubber, with metallic segments having platinum surfaces. The brushes which bear upon the commutators are of phosphor-bronze, with contact points of platinum-iridium. In the illustration, Fig. 3, the commutators for making the telephone test may be seen. The commutator on the hour shaft closes the circuit for 4 minutes. The commutator on the day shaft has 10 segments which are staggered, every other one of these being made inoperative one day a week by the insulated portion of the commutator on the week shaft. Commutators for the other tests which are being controlled by this apparatus are not shown in this picture.

When the circuit through the contacts on the commutators is complete, the current closes one of the master relays which may be seen in Fig. 1 above the automatic apparatus. These are telephone relays of the type No. 118, Western Electric, to which small phosphor-bronze springs have been added to prevent sticking of the relay owing to the current of the multiple-switch solenoid, which flows through the contact for a considerable time. These springs are operative only at the instant when the relay begins to release the armature and do not affect the relay when the magnetized coil first acts on the armature after the circuit is closed. One master relay is provided for each different test excepting for the storage-battery life-test circuit, for which one relay operates the charging circuit and a second relay the discharge circuit. Each relay is connected with an electric counter (Kellogg

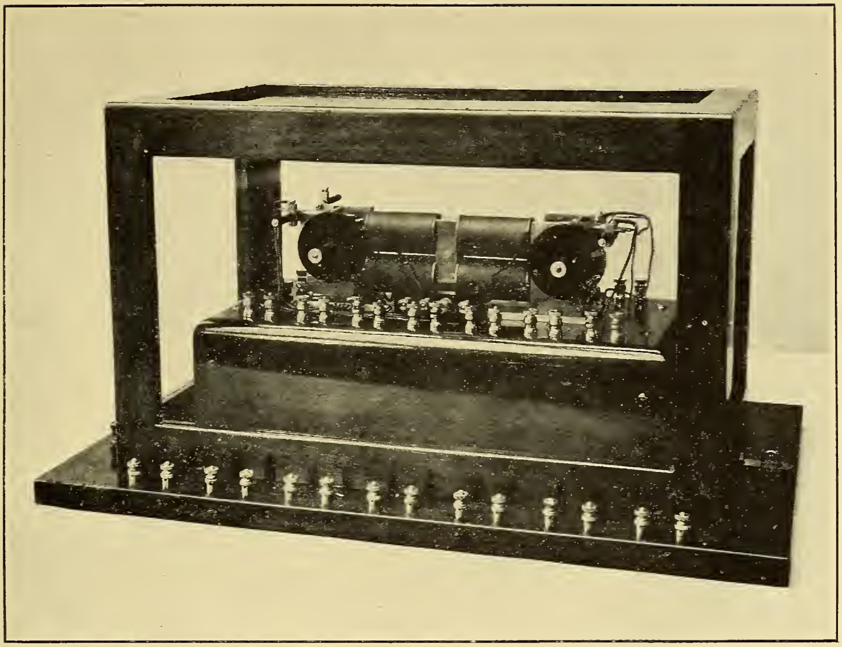

FIG. 2.—*The control apparatus. The shaft at the left makes one revolution per hour, the shaft at the right one revolution per day, and a third shaft at the back (see Fig. 3) one revolution per week*

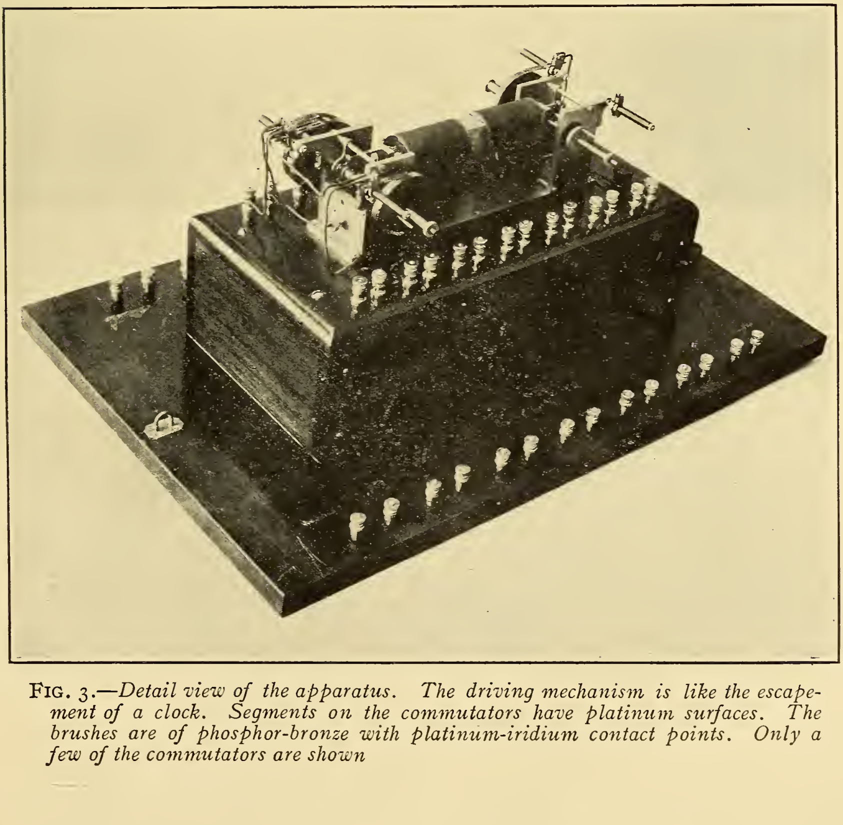

FIG. 3.—*Detail view of the apparatus. The driving mechanism is like the escapement of a clock. Segments on the commutators have platinum surfaces. The brushes are of phosphor-bronze with platinum-iridium contact points. Only a few of the commutators are shown*

message register), which records the number of times that the circuit is closed. A secondary contact in each message register is utilized to light a small signal lamp to indicate which circuit is in operation.

The diagram of the circuits is shown in Fig. 4. Between the clock and the control apparatus there are two relays. The first is within the clock itself; the second is in the box which may be seen immediately beneath the clock in Fig. 1. This second relay is a matter of convenience for other purposes, but is not necessary for the operation of the apparatus. In the locked box with this relay is a snap switch for the 110-volt circuit, also 2 fuses made of gold foil which will burn out if the current exceeds 0.3 ampere. They are to protect the solenoids of the automatic apparatus.

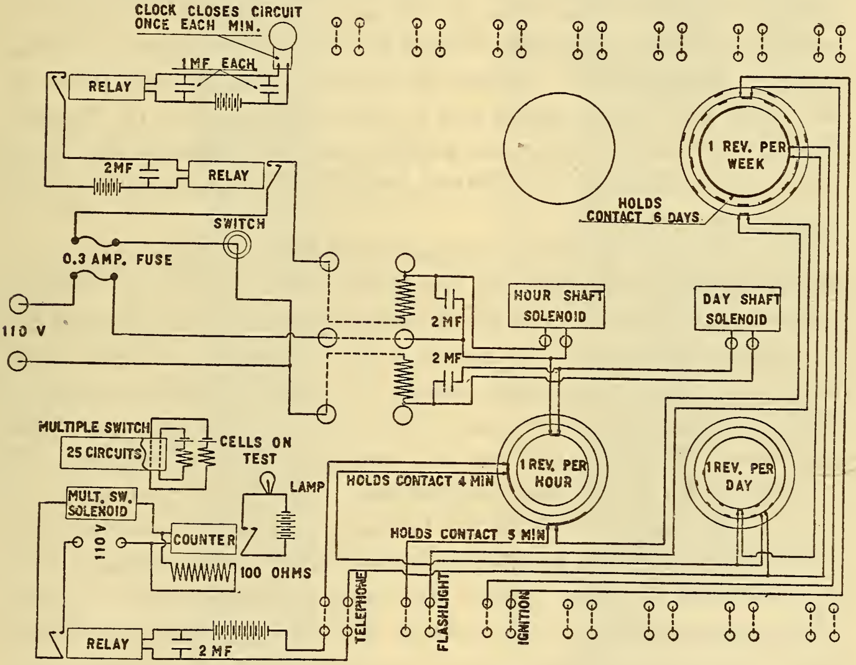

FIG. 4.—*Diagram of the circuits*

The batteries indicated in Fig. 4 may be seen beneath the table in Fig. 1. They are of the copper oxide-zinc type, approximately 300 ampere-hour capacity, made by the Edison Primary Battery Co., the National Carbon Co., and the Waterbury Battery Co. They are assembled in a box on casters and have flexible electrical connections so that they may be rolled out into the room for examination or voltage measurements whenever required.

3. MULTIPLE SWITCHES AND TEST BOARDS

For the dry-cell testing it is necessary to close a large number of independent circuits simultaneously, For this purpose multiple switches, as shown in Fig. 5, are used. The contacts are mercury cups with double break. The switch shown is constructed of "Formica." The upper part of the switch is mounted on pivot hinges and is operated by the solenoid. The current required to operate this solenoid is 0.09 ampere, which is sufficient to give the switch a positive action without being too much current for the secondary contact of the relay. The counterweight, which may be seen at the back, is adjusted to open the switch by gravity and keep it open except when current is flowing through the solenoid. In case of failure of the power circuit at any time the switch opens and avoids overdischarge of the batteries. By disconnecting the switch from the solenoid the top of the switch can easily be thrown back for an examination of all the mercury contacts.[2]

Dry cells such as are in tubular flash-light batteries are easily tested by mounting them on the board shown in Fig. 6. Sliding contacts at the lower part of the board permit an adjustment for any length of battery. A screw with a blunt end supports the battery at the bottom (zinc electrode) and a similar screw with a sharp point at the upper end of the battery makes contact with the brass cap on the carbon rod, clamps the cells together, and securely holds the battery in position. The discharge resistances are 4 ohms for each cell in the battery. These resistances have, therefore, been made up as unit coils of the same dimensions having 4, 8, and 12 ohms. Each coil has lead terminals at its ends, which are gripped by the pointed screws that hold the coil in place—above the battery which is on test. Potential leads from the terminals of each battery pass in a cable along the back of the board and are brought to the telephone jacks beneath the window of the constant-temperature room shown in Fig. 1. Readings are rapidly taken on a voltmeter by the telephone-plug connection while the batteries are discharging.

4. SUMMARY

The apparatus which has been described was designed primarily for testing dry cells and storage batteries. It automatically closes the contacts for the discharge of the dry cells at predetermined

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[2] Since this paper was written we have also used 31-contact relays (Type 331H) made by the North Electric Co. These are provided with wiping contacts suitable for closing the battery circuits.

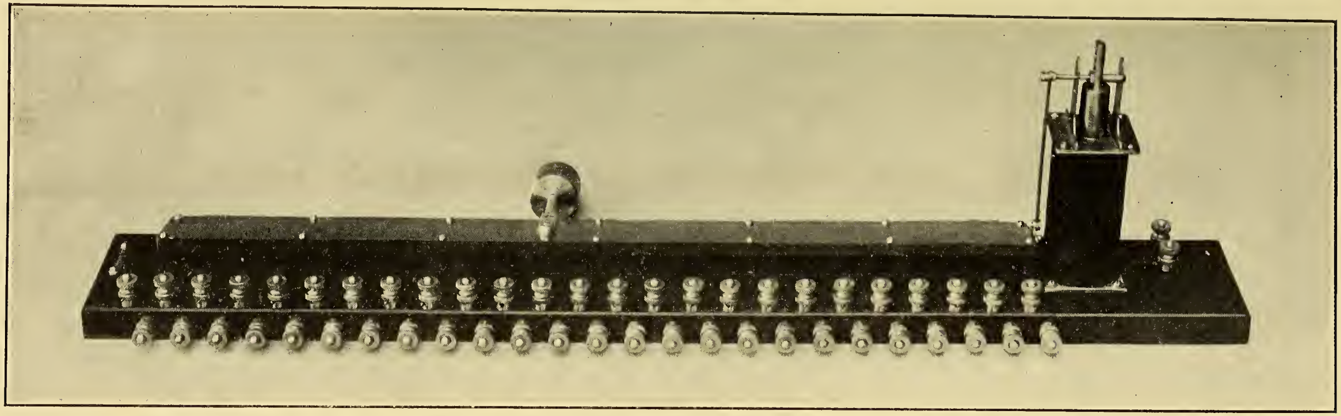

FIG. 5.—*Multiple switch used for dry-cell testing. It is operated by the solenoid at the right, which requires 0.09 ampere. The switch closes 25 circuits for the test board shown in Fig. 6. It is opened by gravity*

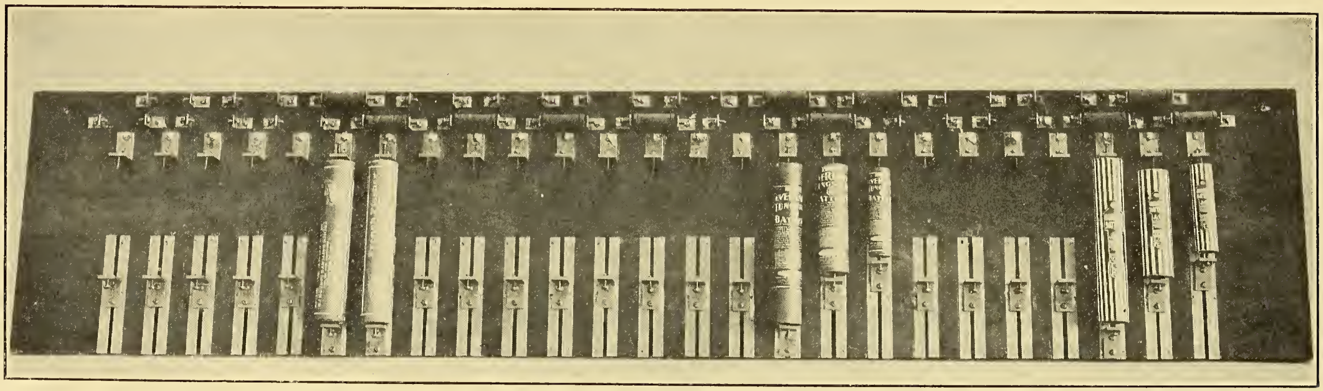

FIG. 6.—*Test board for flashlight batteries. Adjustable contacts provide for any length of battery. Resistance units for the discharge are mounted at the top. Potential leads for each battery are brought to the telephone jacks beneath the window in Fig. 1*

times and controls both the charge and discharge of storage batteries on life tests. The apparatus consists of 2 selective relays having 3 rotating shafts which make complete revolutions in 1 hour, 1 day, and 1 week, respectively. The coils of the first relay are energized once every minute by the clock shown in Fig. 1. The coils of the second relay are energized once each hour by the first relay. In this way rapidly moving parts are eliminated and the accuracy of the time intervals increased. Any periodic test may be controlled by this apparatus by means of suitably designed commutators which are placed on the rotating shafts. The contacts on the commutators are platinum against platinum iridium. Test boards for various sizes of dry cells with multiple switches to close the individual circuits are described.

WASHINGTON, April 22, 1920.

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